

Summary Report

10th U.S. - China Living Marine Resources Panel Joint Coordination Meeting

February 13-14, 2014

The 10th U.S. - China Living Marine Resources (LMR) Panel Meeting was convened in Seattle, Washington on February 13-14. Prof. Liu Yingjie and Dr. Ned Cyr, Co-Chaired the Panel. The Panel meeting was organized into the following five themes:

1. Marine Aquaculture
2. Assessing Natural and Artificial Reef Systems
3. Marine Mammal and Sea Turtle Research
4. Other Collaborative Research Projects and Activities
5. Next Steps for the LMR Panel

Following introductions and the adoption of the agenda, Mr. Keith Chanon and Prof. Jilong Li jointly summarized the projects of the U.S. - China LMR Panel since it last met in October 2012 in Shanghai:

- From September to November 2013, Dr. Huoguo Xu from the Yellow Sea Fisheries Research Institute (YSFRI) worked at the National Oceanic & Atmospheric Administration's (NOAA) Northwest Fisheries Science Center (NWFSC) with Dr. Ron Johnson to investigate the suitability of plant-based proteins (soy and corn) as marine fish feeds.
- The YSFRI and Mote Marine Laboratory (MML) developed a memorandum of understanding to promote research collaboration. Dr. Qian Ma, representing the YSFRI, completed a six month exchange at MML in Sarasota, Florida where she studied the genetic traits of pompano growth heritability and genetic fingerprinting technology.
- In July-August 2013, Drs. Chuan-xin Qin and Xiaoguo Li from the South China Sea Fisheries Research Institute (SCSFRI) participated in a NOAA fisheries oceanographic research cruise. While on the vessel *Oscar Elton Sette*, they learned to utilize advanced photographic and acoustic technologies to assess fisheries dynamics in tropical marine environments. These methodologies can be applied to assess the benefits of artificial reefs for fisheries.

- On February 12, 2014, NOAA hosted a one-day joint workshop on the “Evaluation of Oil Spill Impacts on Fisheries.”
- In September 2013, Prof. Wang Qingyin, Chen Songlin, and Liu Shufang from YSFRI, visited the Mote Marine Lab to discuss further collaboration proposals,
- Dr. Tao Penglong from the Pacific Islands Fisheries Science Center (PIFSC), NOAA made a presentation on fishery statistics at SCSFRI, in June 2013.

The presenters recommended that the Chinese Academy of Fisheries Science (CAFS) and NOAA formalize the establishment of “joint labs” to increase collaborations and scientist exchanges.

Theme 1: Marine Aquaculture (Leaders: David O’Brien and Liu Yingjie)

Linkages with the World Aquaculture Society (Kevan Main)

Kevan Main, on behalf of the World Aquaculture Society (WAS), provided an overview of WAS and its commitment to science and sustainable aquaculture. She encouraged China’s participation in WAS and noted that the Asian Pacific Chapter will hold its 2016 meeting in Guangzhou. This Chapter is working with the China Society of Fisheries and Asian Fisheries Society and plans to expand its membership and services.

U.S. Perspectives – New Developments and Opportunities in Aquaculture Research (David O’Brien)

David O’Brien provided an overview of U.S. aquaculture. He identified the priorities of NOAA’s Aquaculture Program as: 1) increasing U.S. aquaculture production, 2) creating jobs, and 3) ensuring environmental sustainability. He noted that the Food and Agriculture Organization (FAO) and World Bank projections show that in order to feed the global population in 2030, an additional 40-50 million tons of food will be required; and by 2030 nearly two-thirds of all seafood globally will come from aquaculture. A number of barriers prevent the growth of the aquaculture industry in the U.S. These include the permitting process, high costs associated with production, market competition, and environmental concerns. Key areas of interest for joint research with China are: a) feeds, b) genetics, c) ecosystem impacts, and d) stock enhancement.

China Perspectives – The Status, Challenges and Prospects for the Aquaculture Industry in China (Liu Yingjie)

The current status of mariculture development in China was summarized with several key indicators. Total aquatic production reached 59.077 million tons, which accounts for one third of

the world total. Aquaculture, in total capacity, reached 42.88 million tons, which accounts for more than 70% of the world total. The total volume of exports and imports reached 3.80 million tons, with a value of 18.98 billion yuan (over 3 billion USD). Aquaculture ranks the first among agricultural products in China. Considering total production, marine capture is 12.67 million tons, marine aquaculture 16.43 million tons, freshwater capture 2.29 million tons, freshwater aquaculture 26.44 million tons, and pelagic fishery 1.22 million tons. The characteristics of mariculture in China were summarized. Challenges to mariculture in China include environmental sustainability, disease prevalence and lack of genetically improved new varieties. Future strategies will support sustainable development, including integrated multi-trophic aquaculture (IMTA), environmental friendly mariculture, selective breeding, and restocking. Other issues related to management include: 1) management of the release of hatchery reared juveniles for stock enhancement, 2) reformation of the legislation and policy on mariculture certification and classification, and 3) development of a seafood safety and quality control system.

Progress in Collaborative Partnerships: Mote Marine Laboratory (MML) and CAFS-Yellow Sea Fisheries Research Institute (YSFRI) (Kenneth Leber)

Much progress was made in 2013 in this partnership that has teamed MML with YSFRI in pursuit of increased knowledge about marine science and sustainable use of living marine resources. In 2011, after MML scientists were invited by YSFRI to come to Qingdao and to visit the sea-scallop sea ranching operations off of Zhangzidao Island, a Memorandum of Understanding was completed and signed by both organizations. In 2012, after the US-China Living Marine Resources Panel meeting in Shanghai and field trip to Qingdao, YSFRI and MML agreed to place a YSFRI Postdoctoral Research Scientist at MML for 6 months. In August 2013, YSFRI Postdoc, Dr. Qian Ma, arrived at MML from Qingdao to work on a collaboration involving Dr. Ma and scientists at MML, Florida Fish and Wildlife Research Institute (FWRI) on a study of growth heritability in Florida pompano. The collaboration was enhanced with funding from NOAA's Aquaculture Program Office for Dr. Ma's living expenses, FWRI and MML funds for research and administrative support from the University of South Florida. In September 2013, MML hosted three YSFRI scientists in Sarasota, Dr. Qingyin Wang, Dr. Songlin Chen and Dr. Shufang Liu, for meetings and visits at MML's main laboratory in Sarasota and at Mote Aquaculture Research Park. Also in 2013, YSFRI and MML submitted a successful joint application for an "International Science and Technology Cooperation Project of China," which will involve an MML scientist participation in workshops in China to discuss mechanisms for increasing the efficiency of sea ranching and stock enhancement.

Genetic Selection of Pompano Brood Fish Based on the Offspring Growth Trait (Qian Ma)

Florida pompano (*Trachinotus carolinus*) is a high-value marine fish species, which is an excellent candidate for commercial aquaculture in the USA. In this study, candidate broodstock of Florida pompano were genotyped using the selected microsatellite markers, and then only the unrelated adults were chosen for the further spawn. After the mass spawning event, the offspring from 20 breeders were grown into 45 days post-hatch. Subsequently, subsets of fast (515 individuals) and slow (485 individuals) growing progeny were also genotyped. A molecular based parentage assessment was undertaken, and individual parental contributions to larval production were detected and quantified. As a result, six females and five males were contributing to the spawning, respectively. Among the six female contributors, two breeders have the higher fast-growing offspring contribution over 50%. While only one male breeder has the higher fast-growing offspring contribution over 50%. Furthermore, the two couples composed of the above-mentioned two females and one male also turn out to be the best couples in this study.

Advances in Wastewater Recycling Technology of Marine Recirculating Aquaculture Systems (Qu Keming)

Since the 1960s, China's mariculture has roughly experienced five main stages of development including algae culture, shrimp culture, shell fish culture, fish culture, and sea cucumber culture. Recirculating aquaculture systems (RAS) for mariculture have been used due to their advantages such as high culture density in water and land and energy savings. Since the middle of the 1990s, the wastewater recycling technology of marine RAS in China has experienced four important development stages. At each stage, some problems that limited the development of RAS were solved. From 1996-2000, the key techniques of rapid filtration, sterilization and oxygenation were improved and some wastewater equipment, including microstrainers, rapid sand filter tanks and high efficiency oxygen tanks were developed. From 2001-2005, other key technologies including protein skimmers, biofilters and UV disinfectors were developed. From 2006-2010, the focus of research was on the integration and optimization of RAS, and industrial, efficient RAS were built. Beginning in 2011, modern engineering techniques and biological technology were applied in RAS to improve energy efficiency and ecological performance.

Alternative Feeds Research at NOAA (Ronald B. Johnson)

Aquaculture is the fastest growing food-producing sector in the world today, and demand for feed ingredients, especially fishmeal and fish oil, has increased dramatically in recent years. Stocks of pelagic species used in fishmeal production are currently managed at or near maximum

levels of harvest, and further increases in harvest are unlikely. Thus, alternative protein and oil sources are needed to supplement or replace fishmeal and oil in fish feeds, if further development of the aquaculture industry is to be sustained. Nutrient-dense feeds containing high levels of fishmeal and oil approximate the ideal protein and lipid profiles for farmed fish and are efficiently metabolized for energy and growth. Simultaneous replacement of both fishmeal and fish oil by terrestrial alternatives is problematic and total replacement of both has not yet been successful with marine fish. To address these problems, nutritionists at NOAA and the United States Department of Agriculture (USDA) recently sponsored the NOAA-USDA Alternative Feeds Initiative in the United States to systematically investigate the potential of various alternative feed ingredients for fish feeds. This initiative takes a triple bottom line approach to evaluating alternative feed ingredients which takes into account the economic, environmental, and human health consequences of using an ingredient. The three most promising categories of alternative feed ingredients were discussed: plant protein meals, by-product meals from animal processing, and by-product meals from fish processing. Recent advances at NOAA in developing specialty meals from fishery processing waste for use in alternative feeds were also discussed.

Incorporation of Plant Proteins into Marine Finfish Feeds (Ronald B. Johnson)

The replacement of fishmeal and fish oil in marine fish feeds by more sustainable terrestrial alternatives is problematic due to a variety of nutritional concerns and reduced feed intake. Through a scientific exchange with YSFRI, NOAA studied the utility of employing specialty fish meals to facilitate the transition of sablefish *Anoplopoma fimbria* to plant-based feeds. These specialty meals were prepared from fishery processing waste derived from US fish processors and employed either fresh rendering technology developed at the Northwest Fisheries Science Center (NWFSC), or a hydrolysis process developed at YSFRI. The specialty meals were incorporated as minor ingredients in alternative plant based fish feeds, recently developed for sablefish at NWFSC. A 4-week growth trial, focused on measuring feed intake and growth, was conducted with a feed containing freshly rendered Atlantic salmon processing waste (trim), a feed containing an enzymatic hydrolysate prepared from Pacific whiting processing waste (hydrolysate), and a feed containing conventional fishmeal (control). Acceptable growth and feed conversion (FCR) were obtained with all diets, however, trim and hydrolysate fish had significantly higher feed intake and weight gain than control fish ($p < 0.05$). FCR of trim fish was improved over that of hydrolysate and control fish ($p < 0.05$). Results from this study demonstrate the potential of incorporating specialty fish meals into plant based feeds for marine fish to increase feed intake, growth, and improve FCR. Future research is planned between NWFSC and YSFRI researchers to investigate the potential of incorporating macroalgae into alternative feeds containing these specialty meals.

An Overview of NOAA's Coastal Aquaculture Planning and Environmental Sustainability Program (James Morris)

The NOAA National Ocean Service's Coastal Aquaculture Planning and Environmental Sustainability (CAPES) program works to develop coastal planning tools and services to support growth of an environmentally sustainable marine aquaculture industry in the United States. We are building and using environmental models to forecast environmental interactions, developing monitoring protocols, and building tools for marine spatial planning for coastal aquaculture. For more information on CAPES please visit:

http://coastalscience.noaa.gov/research/scem/marine_aquaculture.

Bioremediation Facilities and Techniques for the Degraded Biological Resources in Typical Bay Areas of China (Yang Hongsheng)

Coastal habitats and bio-resources are severely threatened by frequent human activity and changes in the global environment. Remediation techniques are essential to cope with worsening ecological conditions. Systematic bio-remediation techniques were applied in three typical bays of the Shandong Peninsula of China: Laizhou Bay, Rongcheng Bay and Haizhou Bay.

The fishery resource status and ecosystem health status were first assessed and key problems of the three bays were identified. A number of strategies were used for habitat remediation, including the design of new types of artificial reefs and the seeding and transplanting of Eelgrass and seaweed. Results of the study concluded that water quality improved and biodiversity increased after applying these techniques at the study sites.

Theme 2: Assessing Natural and Artificial Reef Systems (Leaders: Jason Cope, NOAA, Prof. Li Chunhou, CAFS)

Modeling the Shape and Design of Artificial Reefs (Li Chunhou)

Various types of artificial reefs have been used in China. Since the 1970s, small-scale artificial reefs have been developed to: a) protect marine resources in marine protected areas; b) improve fishing quality; and c) develop recreational fishing. The engineering performance and ecological effects are the two factors that influence the design of artificial reefs. Engineering performance includes stability (anti-slide, anti-roll, buoyancy) and water flow characteristics. Ecological effects include bio-fouling and bio-attraction. Experiments are conducted to compare the efficacy of artificial reefs.

Assessment Methodologies for Reef Systems and China's Participation in a NOAA Oceanographic Research Cruise (Jason Cope, Li Chunhou)

Dr. Jason Cope and Prof. Li Chunhou presented on joint efforts to develop assessment methodologies for reef systems. In July-August 2013, two scientists from the South China Sea Fisheries Research Institute participated in a NOAA survey in Hawaii to learn techniques for assessing fisheries dynamics in tropical marine environments.

Cooperative research efforts between U.S. and Chinese scientists have investigated the feasibility of collecting fishery-independent abundance estimates for fishes occupying untrawlable habitat. This study was conducted off the Hawaiian Islands and considered four surveying approaches: 1) boat-based hook-and-line survey; 2) stationary video camera (“BotCam”); 3) roving autonomous underwater vehicle (AUV); and 4) acoustic survey. Each approach was conducted over different habitat types, depths and slopes. Data are currently being examined and will soon provide insight as to which method can be recommended for ongoing application to assess the productivity of reefs in both countries.

Theme 3: Marine Mammal and Sea Turtle Research (Leaders: John Bengtson, NOAA, Prof. Li Chunhou, CAFS)

Gray Whales in the Western North Pacific: Joint Research and Recent Scientific Findings (Dave Weller)

While recent observations have documented gray whales (*Eschrichtius robustus*) identified in the western North Pacific (WNP) off Sakhalin Island, Russia, migrating to areas off the coast of North America (Canada, California, Mexico) during the winter/spring, the past and present occurrence of gray whales off Japan and China (and the Korean Peninsula historically) suggest that not all gray whales identified in the WNP share a common wintering ground. Contemporary records of gray whales off Asia are rare, with only 13 from Japanese waters between 1990 and 2007 and 24 from Chinese waters since 1933. The last known record of a gray whale off Korea was in 1977. Although recent observations of gray whales off the coast of Asia are infrequent, they nevertheless continue to occur, including: (1) March 2012 - a gray whale was sighted and photographed in Mikawa Bay (Aichi Prefecture), on the Pacific coast of Honshu, Japan, and (2) November 2011 - a 13 m female gray whale was taken in fishing gear offshore of Baiqingxiang, China, in the Taiwan Strait. Observed genetic differentiation between western and eastern gray whales, in combination with sighting/stranding records from Japan and China during the winter/spring lead experts to believe that a relic WNP gray whale population still exists and obtaining information on its present day status off China is of vital importance to conservation objectives.

Spotted Seals: The Yellow Sea as a Preview of a Future, Warmer Arctic? (Peter L. Boveng)

The spotted seal, *Phoca largha*, is an ice-associated species whose range extends from the Alaska coastal waters of the Beaufort Sea to the Yellow Sea in China. This vast, trans-boundary expanse encompasses a broad range of climatic conditions so that the southwestern end--along the Yellow Sea coasts of China and Korea--is substantially warmer with less regular and extensive sea ice coverage than the majority of the range, in the Sea of Okhotsk and Bering Seas. The conditions for spotted seals in China may thus be an analog of future conditions expected in more northerly parts of the range under a disrupted and progressively warming climate. Although the species' habits in the southern parts of its range are poorly documented in western scientific literature, there are indications that spotted seals may be persisting by breeding on shore in the Yellow Sea and Sea of Japan. This is in stark contrast to the natural breeding habitat for the species, on the sea ice, where the white-coated pups are camouflaged and relatively safe from predators and disturbance. Spotted seals in China face other serious conservation risks from pollution, coastal development, mortality in fisheries, and poaching. A scientific collaboration and exchange between China and the U.S. would enhance the quality of status assessments and conservation efforts for this species throughout its range.

Sea Turtle Research and Conservation in China (Li Chunhou)

In China, sea turtles are primarily found in the South China Sea and this is where the only national sea turtle nature reserve is located (Guandong Sea Turtle Reserve). Potential research activities with NOAA have been identified by the joint U.S.-China working group. CAFS is interested in supporting the organization of a sea turtle health assessment and foraging ecology workshop in the summer of 2014.

New Developments for Joint Research Collaborations on Sea Turtles (Jeff Seminoff)

The People's Republic of China and the U.S. Pacific have significant foraging and breeding habitats for sea turtles. Sea turtles play an important cultural role in Chinese society, and there is increasing interest on the part of marine scientists in China to gain greater knowledge about the ecology and conservation of sea turtles in the China region. Furthermore, sea turtles regularly travel across international borders during their life history, hence factors adversely impacting sea turtles have ramifications across broad areas of the Pacific. In April 2012, a US-China LMR Panel Meeting was convened in Shanghai, China. During this meeting, representatives attended from the U.S. National Marine Fisheries Service, CAFS, and Guangdong Huidong Sea Turtle National Nature Reserve Management Bureau (The Reserve). During the meeting, the China-US LMR Panel identified two potential projects as the initial sea turtle research collaborations

among the team. These included 1) studying foraging ecology of sea turtles in coastal China and 2) analyzing existing telemetry data from China to explore oceanographic influences on sea turtle movements. Although these efforts are still in initial stages, as a result of the partnerships forged at this meeting, Zhang Feiyan (Gangkou Sea Turtle Reserve, China) visited Honolulu, HI in September 2012 as part of a scientist exchange effort. She was hosted by George Balazs (NMFS Pacific Islands Fisheries Science Center) and took part in a variety of activities including sea turtle necropsies, sea turtle capture, visiting important green turtle foraging areas, etc. This marked the first step in greater collaboration and dialogue among Chinese and U.S. Scientists and expanded the potential for information exchange between China and the U.S. for greater understanding of sea turtle biology for improved management and cooperation. It is hoped that additional collaborative efforts are started in the near future to benefit sea turtles throughout the Pacific, but especially in China and the United States.

Theme 4: Other Collaborative Research Projects and Activities (Leaders: Keith Chanon, NOAA, Prof. Li Jilong, CAFS)

Restoration and Assessment of the Carbon Sink Potential of Intertidal Oyster Reefs in the Yangtze River Estuary, China (Shen Xinqiang)

With the adoption of the Kyoto Protocol to the United Nations Framework Convention on Climate Change in 2005, the potential of using fisheries as carbon sinks became an important fishery science topic in China. Oyster reefs are very important marine habitats in temperate estuaries and coasts, providing a large number of services and goods such as fishery production, water purification, fish habitat, maintenance of biodiversity, erosion control etc. So far, little information is available on the carbon sink potential of oyster reefs. The present study aimed to assess the restoration and carbon sink potential of a man-made intertidal oyster reef in the Yangtze River estuary, China. The oyster (*Crassostrea sp.*) population rapidly increases with reef development, and its mean density and biomass reached the highest at approximately one year after restoration (in June 2005). Thereafter, the mean oyster density decreased with the increase in the mean size of the oyster. The species richness, density and biomass of resident macro-benthos (exclusive of oyster and barnacles) in the restored oyster reef showed a gradually increasing trend. The study recorded a total of 47 macro-benthos species, the mean density of 941 individuals/m² and biomass of 44.51 g/m² in 2010. The restored intertidal oyster reef has a strong carbon sink potential of about 2.70 kg/m², can lock up 3.33×10^4 tons carbon/ year through the calcification process, and produced ecological value of approximately 8,370,000 RMB per year, which is equivalent to restoring 1,110 hm² of tropical forest.

Olympia Oyster restoration in Washington State: A Partnership with Puget Sound Restoration Fund (Walt Dickhoff)

The Northwest Fisheries Science Center is beginning a collaborative effort to restore native Olympia oyster (*Ostrea lurida*) in Puget Sound. A restoration shellfish hatchery is near completion (May 2014) at the Center's Manchester Research Station in Puget Sound. Olympia oyster is the only native oyster on the west coast of the United States. Its numbers have declined since the late 1890s, so that now self-sustaining populations only exist in 4% of its historic distribution. The decline in Olympia oyster abundance was due to overharvest and habitat degradation. Efforts have begun in recent years to restore Puget Sound habitat by federal, state, local governments, tribes, and non-governmental organizations (NGOs) include oyster reef restoration. Oyster reef restoration provides many benefits, including recovering native species, rebuilding marine habitat, restoring ecosystem function and species diversity, mitigating nutrient pollution, improving marine water quality, and monitoring for ocean acidification. The restoration of Olympia oyster relies on collaboration with Puget Sound Restoration Fund, an NGO that has been working on Puget Sound restoration since 1997. The goal of the collaborative effort is to provide up to 10 million oyster seed per year to enhance populations in 40 hectares in Puget Sound by 2020. Genetically defined stocks of oysters will be planted and studied to ensure appropriate genetic diversity is retained. Successful restoration will be determined using various criteria, including establishing self-sustaining populations at a density of at least 75 oysters/m².

***Euphausia Pacifica*: A Euphausiid (krill) Species of Trophic and Economic Importance Throughout the North Pacific (Bill Peterson)**

There is considerable interest in studying the krill, *Euphausia pacifica*, in the Yellow Sea and East China Sea because this species is a key link in the food chain between phytoplankton and fishes. This species is unique in that it can feed upon very small phytoplankton particles (as small as 3-4 µm) as well as large diatoms and ciliates thus this species can survive and even prosper in a wide variety of both oligotrophic as well as eutrophic ecosystems, in coastal as well as oceanic waters. *Euphausia pacifica* is broadly distributed throughout the coastal and oceanic waters of the Western Pacific ranging from the very cold waters offshore of the Sea of Okhotsk, then south through the Oyashio Current, the Japan/East Sea, the Yellow Sea, and the East China Sea. Given their ability to survive in a wide variety of ecosystems, it is not surprising that this species dominates the euphausiid assemblage in the Yellow and East China Sea.

Although it is well known that this species is the dominant form in marginal seas of China, our knowledge of their seasonal cycles of abundance, age structure and rates of growth, production and consumption are not well known. Significant research has been done both at the East China

Sea Fisheries Science Center in Shanghai (CAFS) by Dr. Zhao Li and at the Institute of Oceanology, Chinese Academy of Sciences in Qingdao by members of Prof Sun Song's laboratory, however far more work is needed on inter-annual variations in abundance and biomass as well as on trophic ecology. One topic of interest is the degree to which the population in the Yellow Sea supplies animals to the East China Sea. Other research topics of interest include the ecology of the giant jellyfish, *Nemopilema nomurai* and studies of the flux of plankton as waters flow past aquaculture rafts and farms.

Monitoring Human Caused Coastal Habitat Changes and its Impacts to Near-Shore Ecosystems Using Remote Sensing (Li Jilong)

Prof. Li presented the general situation of coastal habitat changes caused by humans. Taking Bohai Bay as the area of study, methods of segmentation (multi-resolution) and classification (nearest neighbor) with nine years (1987, 1997, 2005-2011) of Landsat TM remote sensing data were applied to detect the spatial and temporal changes in coastal habitats. The marine ecosystem survey data were also collected and processed to find the changes of macro benthos species composition, abundance, biomass, diversity and dominant species within the same period. The results showed a close relationship between the macro benthos diversity degradation and mudflat and shallow sea losses.

Remote Sensing Tools and Applications for Coastal Habitats (Kristan Blackhart)

NOAA uses a variety of tools to collect geospatially-linked data in support of its mission and mandates. Remote sensing technologies play an increasingly important role in NOAA's data collection efforts. In addition to the satellites and planes traditionally employed to collect data remotely, a variety of other platforms are important in the collection of data (both remotely and in situ) to support the conservation and management of living marine resources. These include buoys, acoustically quiet fishery survey vessels, autonomous underwater vehicles, and unmanned aircraft systems. Advanced technology optical and acoustic sensors are further enhancing data collection capabilities by providing less invasive and non-extractive methods to rapidly survey large areas with high spatial resolution. Much of NOAA's coastal geospatial data can be freely accessed through the Digital Coast website (<http://www.csc.noaa.gov/digitalcoast/>). In addition to efficient and effective data access, Digital Coast also helps users turn data into information by providing tools, training, and cases studies addressing a range of coastal management needs. The Coastal and Marine Ecological Classification Standard (CMECS) is another important tool facilitating data sharing and integration by providing a simple and standard classification terminology. Geospatial data is applied by NOAA scientists to investigate an assortment of management questions, including population status, habitat vulnerability, restoration planning,

and climate change impacts. A key area of interest involves the use of available information to learn about the relationship between habitat quality/quantity with the health and abundance of living marine resource populations and fisheries production.

NMFS and other NOAA Offices have considerable experience using remote sensing technology. NMFS Science Centers can facilitate collaboration on this subject.

Outcomes from the Joint Oil Spill Workshop (John Incardona)

Immediately preceding the LMR Panel Meeting, a one-day U.S.-China joint oil spill workshop was held in Seattle. Discussions focused on methods to determine the impacts on fish from oil spills. NOAA researchers described various studies focused on U.S. oil spills. In addition, they provided an in-depth review of the regulatory process used to conduct damage assessments and determine the cost for restoration. CAFS shared information about oil spills in China and its process for valuing environmental damage. Representatives from both countries agreed that another workshop to address economic assessments would be useful in addition to increasing the routine exchange of information and current research to increase the understanding of oil spill impacts on ecosystems and spawning grounds.

Tropical Fish Stock Assessments and Conservation Advice (Jason Cope)

The art of stock assessment in tropical marine environments has undergone much development over the last decade, but the last journal article to capture these advances was published in 1998. The need to discuss and document these new approaches in a form that can be shared will help promote their use in developing countries. The time is now to convene a tropical reef fish assessment and conservation symposium to provide the arena to promote new and updated approaches to stock assessment in data-limited situations. Training sessions should be conducted prior to the symposium to maximize its effectiveness. Such training sessions should be on-going to ensure success and facilitate advances in managing tropical reef fishes.

Theme 5: Next Steps for the LMR Panel (Leaders: LIU Yingjie, CAFS and Ned Cyr, NOAA)

1. How to facilitate staff/scientist exchanges?

The U.S. Chair supported the idea of designating joint labs for collaboration. Joint-lab models exist informally between YSFRI and Mote Marine Lab, NWFSC and SCSFRI, and between PIFSC and SCSFRI. The LMR Panel should identify a more formal platform through MOUs or other types of agreement. The Chinese Chair indicated that China has established quite a few co-labs, including two in the U.S. Identification of

projects of interest for both countries would be important for developing co-labs.

2. U.S.-China Science Symposium

The idea of establishing a symposium would be based on the symposium series that Gerard DiNardo organized with the Shanghai Ocean University. An opportunity may exist to organize a similar event in conjunction with the NOAA and Chinese State Oceanic Administration (SOA) Marine Science Symposium, tentatively planned for 2015. NOAA and CAFS will convey this idea to the appropriate contacts in each agency.

3. Identification of Joint Research Projects and Activities

The panel identified the following areas for potential joint research projects:

- Aquaculture feeds (SCSFRI, YSFRI and NWFSC (Ron Johnson)
- Aquaculture modeling (James Morris)
- Climate impact on aquaculture (IOCAS: Yong Hongsheng, SCSFRI: Li Chunhou, NMFS: David O'Brien)
- Oyster hatcheries (IOCAS: Yong Hongsheng, ECSFRI: Shen Xinqiang, NWFSC: Walt Dickhoff)
- Exchange information on recycled water systems and management of solid wastes (YSFRI: Qu Keming and NWFSC: John Colt)
- Scientist visit and information exchange on spotted seals: (CAFS: Li Jilong, AFSC: John Bengtson and Peter Boveng)
- Remote Sensing Technologies for coastal marine environments (CAFS: Li Jilong and NMFS: Keith Chanon)

4. **Next Meeting:** The panel proposed that the 11th China – U.S. LMR Panel Meeting be held in Guangzhou, China in March, 2016.



Ned Cyr, Ph.D
U.S. Chair



Liu Yingjie, Professor
Chinese Chair

Appendix I

Action Items

- I. World Aquaculture Society (WAS) (Kevan Main, Li Jilong)
 - a. Focus on expanding global membership, especially in China. Opportunity to partner with CAFS.
- II. Aquaculture
 - a. Increase scientist exchanges:
 - i. Continue to strengthen collaboration on genetics and stock enhancement (MML and YSFRI)
 - ii. Continue to strengthen collaboration on feeds development (NWFSC, YSFRI, SCSFRI)
 - iii. Create a visiting scientist position at NOAA labs. NWFSC has available lab space, material resources, but is lacking personnel
 - iv. Enable US scientists to conduct research at laboratories in China
 - b. New Topics of Interest:
 - i. Begin collaborating on monitoring and modeling for coastal aquaculture (NOS, SCSFRI, YSFRI)
 - ii. Climate Change: Address ecosystem interactions with aquaculture (CAS: Prof. Yang, David O'Brien)
 - iii. Marine Cage Culture – Need more information from China – exchange information on studies not available in the open literature
 - iv. Use of shellfish for bioremediation purposes
 - v. Exchange information on recycled (closed) water systems and management of solid wastes (Prof. Qu, Prof. Li & Dr. Colt (NWFSC)
 - vi. Evaluation of the effectiveness of stock enhancement activities
- III. Assessment of Reef Systems (Gerard Dinardo, Li Chunhou)
 - a. Establish Joint Laboratory relationship between SCSFRI and PIFSC
 - b. Complete articles describing fisheries management in Guangdong Province
 - c. SCSFRI to complete proposal for restoration and assessment techniques of fishery resources with PIFSC
 - d. Develop stock assessment models for reef species in Guangdong province that account for habitat and stock enhancements.
 - e. Gerard DiNardo to report on latest survey study results in March. Will make recommendations on survey approaches to SCSFRI
 - f. SCSFRI – Plans to move ahead with ARMS deployment in China

IV. Marine Mammals and Sea Turtles

- a. Western Gray Whale (Dave Weller, SOA)
 - i. Dave Weller and Bob Brownell hope to travel to China in October/November 2014 to conduct local ecological knowledge surveys to obtain information on the occurrence, distribution, habitat use and numbers of western gray whales in the coastal waters of China, increase public awareness about gray whales in China, and create a way for sighting information to be reported. NOAA/IWC funding (\$15k for this project). Need \$5k for Dr. Zhou's (SOA) domestic travel.
- b. Spotted Seal Research (Li Jilong, Peter Boveng)
 - i. Li Jilong to provide contacts in China (Ministry of Agriculture) who may be interested in collaborating with NOAA. Peter to exchange a list of contacts.
 - ii. AKFSC (Marine Mammal Lab) invites a Chinese scientist to visit the lab.
- c. Sea Turtle Research (Li Chunhou, Jeff Seminoff)
 - i. CAFS interested in foraging ecology, health assessment, climate change on spawning migration and contaminant effects on eggs.
 - ii. CAFS to indicate ability to participate in the proposed US-China workshop on sea turtle foraging ecology and health assessment planned for 2014 (4 days in Hawaii).
- d. *Euphausia Pacifica* (Krill) and Climate (Hongsheng Yang, Bill Peterson)
 - i. CAS (Hongsheng Yang) and Bill Peterson to explore opportunities for joint research

V. Remote Sensing (Li Jilong, Keith Chanon)

- a. CAFS proposal for joint projects on study of coastal habitats/ecosystem changes based on remote sensing techniques; staff exchange and training in use of remote sensing; establishment of a joint lab relationship with NOAA. NMFS to explore interest from other NOAA programs. Priority is on joint research.

VI. Oyster Reef Ecology (Shen Xinqiang, Walt Dickhoff)

- a. Explore opportunities for exchanging information.

VII. Oil Spill Workshop (Qu Keming, Shen Xinqiang, John Incardona)

- a. Based on the information exchange at the workshop, CAFS will provide a proposal identifying specific areas for collaboration. Priority interests included sharing assessment methods for ecological toxicity and seafood safety.

- VIII. Symposium on Stock Assessments for Tropical Marine Systems (Gerard DiNardo, Li Chunhou)
- a. Focus on assessment modeling, monitoring, stock enhancement, life history and conservation advice. Include a training session prior to the symposium (development of a manual)
 - b. NMFS and CAFS to explore venues and outside support. Should link to the International Working Group on Data-Limited Approaches for contacts in the region (Asia).

Appendix II

10th U.S. – China LMR Panel Meeting Agenda

The Edgewater Hotel
Seattle, Washington, USA
February 13-14, 2014

Meeting Objectives:

- *Exchange knowledge between the Chinese and U.S. scientists for supporting the management of living marine resources*
- *Review the status and progress of joint activities*
- *Identify joint priorities and specific areas for collaboration (short and longer-term activities) and identify mechanisms and resources to sustain cooperation and joint activities over the next five years*

Thursday February 13

9:00 Opening Statements

- Dr. Ned Cyr, U.S. Chair
- Dr. LIU Yingjie

9:20 Self-introductions by participants

9:30 Adoption of the Agenda & Assignment of Rapporteurs

- Dr. LIU Yingjie
- Dr. Ned Cyr

Rapporteurs:

- Mr. Keith Chanon, Dr. Jihong Dai, Prof. LI Jilong

9:40 Overview of the U.S.– China LMR Panel and Collaborative Research Activities in 2013

- Prof. LI Jilong and Mr. Keith Chanon

Theme 1: Marine Aquaculture

(Leaders: David O'Brien, NOAA; Dr. LIU Yingjie, CAFS)

10:00am Linkages with the World Aquaculture Society (Kevan Main, Mote Marine Lab)

New Developments and Opportunities in Aquaculture Research:

- 10:10am U.S. Perspectives (David O'Brien and Mike Rust, NOAA)
- 10:25am China Perspectives (Dr. Liu Yingjie, CAFS)
- 10:40am Break

Stock Enhancement/Artificial Reefs:

- 11:00am Mote Marine Lab Collaborations with the Yellow Sea Fisheries Research Institute (Ken Leber, Mote Marine Lab)
- 11:15am Genetic Traits of *Pompano* that Affect the Species' Growth (Ma Qian, *on exchange to Mote Marine Lab from CAFS, YSFRI*)
- 11:35am Industrialized Marine Aquaculture using Water Recirculation Systems (Qu Keming, CAFS)
- 11:55pm Open Discussion and Next Steps
- 12:15pm Lunch

Alternative Feeds Research:

- 1:25pm Overview of China Research Activities (Liu Yingjie, CAFS)
- 1:40pm Overview of U.S. Research Activities (Ron Johnson, NOAA)
- 1:55pm Joint Research Activities between the Northwest Fisheries Science Center and Yellow Sea Fisheries Research Institute (Ron Johnson, NOAA)
- 2:15pm Open Discussion and Next Steps

Modeling and Monitoring the Environmental Impacts of Aquaculture Operations

- 2:35pm Siting Aquaculture Operations with Respect to Environmental Sustainability (James Morris, NOAA)
- 2:55pm Bioremediation Facilities and Techniques for the Degraded Biological Resources in Typical Bay Areas in China (Yang Hongsheng, CAS)
- 3:15pm Open Discussion and Next Steps
- 3:35pm Break

Theme 2: Assessing Natural and Artificial Reef Systems
(Leaders: Jason Cope, NOAA, Prof. Li Chunhou, CAFS)

NOAA – CAFS Joint Activities:

- 3:50pm Modeling the Shape and Design of Artificial Reefs (Li Chunhou, CAFS)

- 4:10pm SCSFRI Participation in the July-August Fisheries Oceanography Cruise on the *Oscar Elton Sette* and Assessment Methodologies for Reef Systems (Jason Cope, NOAA)
- 4:25pm Joint Cruise and Stock Assessments for Reef Systems (Li Chunhou, CAFS)
- 4:45pm Open Discussion and Next Steps
- 5:05pm Announcements, Group Photo, and Adjourn for the Day

Friday, February 14

Theme 3: Marine Mammal and Sea Turtle Research

(Leaders: John Bengtson, NOAA, Prof. LI Chunhou, CAFS)

- 8:30am Gray Whales in the Western North Pacific: Joint Research and Recent Scientific Findings (Dave Weller, NOAA)
- 8:50am Spotted Seal Research Conservation in the Yellow Sea (Peter Boveng, NOAA)
- 9:00am Current Status of Sea Turtle Research in China and Future Cooperation Highlights (LI Chunhou, CAFS)
- 9:20am New Developments for Joint Research Collaborations on Sea Turtles (Jeff Seminoff, NOAA)
- 9:40am Open Discussion – Next Steps for Collaboration on Marine Mammals and Sea Turtles

Theme 4: Other Collaborative Research Projects and Activities

(Leaders: Keith Chanon, NOAA, Prof. Li Jilong, CAFS)

- 10:00am Oyster Reef Ecology Restoration in the Estuary of Yangtze River (Shen Xinqiang, CAFS)
- 10:15am Native Oyster Hatcheries (Walt Dickhoff, NOAA)
- 10:30am *Euphausia Pacifica* (Krill) and Climate (Bill Peterson, NOAA)
- 10:45am Break
- 11:00am Remote Sensing Monitoring Technologies for Marine Estuaries and Coastal Habitats: Opportunities for Collaboration (Li Jilong, CAFS and Kristan Blackhart, NOAA)
- 11:30am Outcomes from the Joint Oil Spill Workshop (Nat Scholz, NOAA, Qu Keming and Shen Xinqiang, CAFS)
- 11:55am Proposal for a Symposium on Stock Assessments for Tropical Marine Systems (Jason Cope, NOAA)

12:10pm Open Discussion and Next Steps

12:30pm Lunch

Theme 5: Next Steps for the LMR Panel

(Leaders: LIU Yingjie, CAFS and Ned Cyr, NOAA)

1:30pm Next Steps Discussion

1. How to Facilitate Staff/Scientist Exchanges?
2. Potential for a continuing US-China Science Symposium Series
3. Identification of Joint Research Projects and Activities
4. Discussion of the Next Panel Meeting (location, timing, other issues)

2:15pm Closing Remarks by the Chinese and U.S. Co-Chairs

3:30pm Visit to the Northwest Fisheries Science Center

Appendix III

Meeting Participants

U.S. Participants

1. Ned Cyr, HQ/ST, Ned.Cyr@noaa.gov
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6. Bill Peterson, NWFSC, Bill.Peterson@noaa.gov
7. Xiuning Du, NWFSC, Xiuningdu@gmail.com
8. Ken Leber, Mote Marine Lab, kleber@mote.org
9. Kevan Main, Mote Marine Lab, kmain@mote.org
10. Ma Qian, Mote Marine Lab/YSFRI maqian@ysfri.ac.cn
11. James Morris, NOS, james.morris@noaa.gov
12. Mike Rust, HQ/Aquaculture, Mike.Rust@noaa.gov
13. John Bengtson, AFSC/MML, John.Bengtson@noaa.gov
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15. Alex Johnston, HQ/IA, Alex.Johnston@noaa.gov
16. Kristan Blackhart, HQ/ST, Kristan.Blackhart@noaa.gov
17. Jason Cope, NWFSC, Jason.Cope@noaa.gov
18. Walt Dickhoff, NWFSC, Walton.W.Dickhoff@noaa.gov
19. Loh Lee Loh, AFSC, loh-lee.low@noaa.gov
20. John Stein, NWFSC, John.Stein@noaa.gov
21. Jeff Seminoff (by phone), SWFSC, Jeffrey.Seminoff@noaa.gov
22. Dave Weller (by phone), SWFSC, Dave.Weller@noaa.gov

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